# Digital Elevation Models of South Texas Coast: Procedures, Data Sources, and Analysis

Prepared for the Consumer Option for an Alternative System to Allocate Losses (COASTAL) Act and Bipartisan Budget Act of 2018: NOAA Supplemental Funding for Hurricanes Harvey, Irma, and Maria by the NOAA National Centers for Environmental Information (NCEI)
December 31, 2020
Amante, C.J., M.R. Love, M.R. Stiller and K.S. Carignan

Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO
NOAA National Centers for Environmental Information, Boulder, CO

# Summary

In December of 2020, NOAA's National Centers for Environmental Information (NCEI) developed integrated bathymetric–topographic digital elevation models (DEMs) according to specifications developed jointly by NOAA NCEI and the United States Geological Survey (USGS) to help better define a consistent elevation mapping framework for the nation (Table 1). Overall, 53 tiled DEMs were created in the area of interest: 44 tiles were created at the highest resolution of 1/9$^{th}$ arc-second and 9 were created at a resolution of 1/3$^{rd}$ arc-second. Only 1/9$^{th}$ arc-second DEM tiles integrate topography and bathymetry. The DEM tiles represent best publicly-available data at the time of their creation; the intent is to update specific tiles as new source data become available. The utilization of a tiling scheme in developing the DEMs is intended to improve data management during source data processing as well as facilitate targeted DEM updates.

The South Texas DEM tiles were updated to incorporate post-Hurricane Harvey topographic and bathymetric datasets from NOAA, USGS, and U.S. Army Corps of Engineers (USACE) to support the Bipartisan Budget Act of 2018: NOAA Supplemental Funding for Hurricanes Harvey, Irma, and Maria. The tiled DEMs cover the South Texas coast between Brownsville near the Mexico - United States border and Victoria, which importantly includes the Corpus Christi region. The extents of these DEMs, procedures, data sources, and analysis are described below. The methodologies used by NCEI in developing DEMs are described in the NOAA National Centers for Environmental Information Topo-Bathymetric Digital Elevation Models: East Florida (Amante, 2018).

**Table 1.** Specifications for the DEM tiles.

| *Grid Area* | *South Texas Coast* |
|---|---|
| Coverage Area | 98.00° to 96.50° W, 25.75° to 29.00° N |
| Coordinate System | Geographic decimal degrees |
| Horizontal Datum | NAD 83 |
| Vertical Datum | NAVD 88 |
| Vertical Units | Meters |
| Cell Size | Variable (1/9$^{th}$ or 1/3$^{rd}$ Arc-Second) |
| Grid Format | Geotiff |

# DEM Specifications

The South Texas tiled DEMs were built to the specifications listed in Table 1. Figure 1 shows the 1/9$^{th}$ arc-second DEM tile boundaries in orange and the 1/3$^{rd}$ arc-second DEM tile boundaries in green.

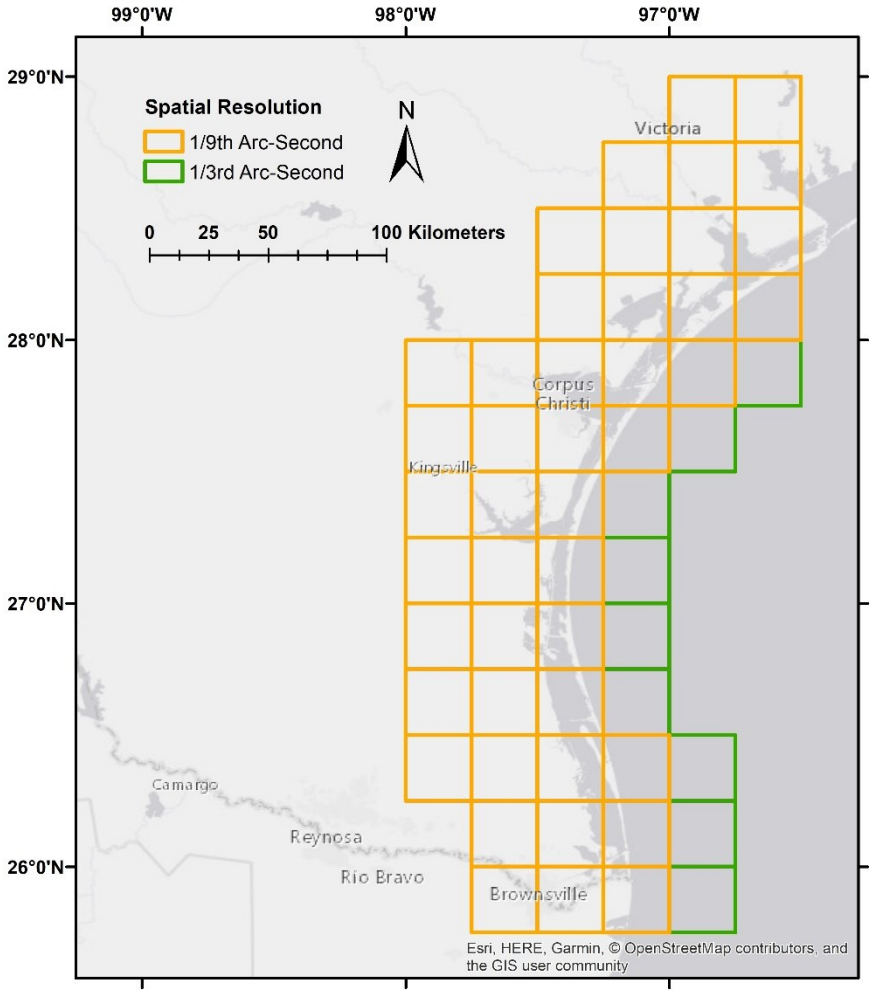


**Figure 1.** Map image of the DEM tile boundaries for the South Texas Coast DEMs.

# Data Sources and Processing

Bathymetry data used in the generation of the South Texas Coast DEMs included NOAA National Ocean Service (NOS) hydrographic surveys and bathymetric attributed grids (BAGs), NOAA Office of Coast Survey (OCS) electronic navigational charts (ENCs), NOAA NCEI multibeam survey data, USACE channel condition surveys, and Texas Water Development Board Volumetric and Sedimentation Survey of Lake Texana (Table 2).

**Table 2:** Bathymetric data sources used in DEM development.

| ***Source*** | ***Date*** | ***Date Type*** | ***Spatial Resolution*** | ***Horizontal Datum*** | ***Vertical Datum*** |
|---|---|---|---|---|---|
| NOAA NOS hydrographic surveys | 1934 - 2006 | XYZ | < 10 meters to several kilometers | NAD83 | Mean lower low water (MLLW) |
| NOAA OCS electronic navigational chart (ENC) extracted soundings | 1966 - 2019 | XYZ | < 10 meters to several kilometers | WGS84 | Mean lower low water (MLLW) |
| NOAA NOS hydrographic surveys: bathymetric attributed grids (BAGs) | 2005 - 2017 | BAGs | 0.5 to 5 meters | NAD83 | Mean lower low water (MLLW) |
| NOAA NCEI multibeam bathymetric surveys | 2008 - 2016 | XYZ | ~1 to 10 meters | NAD83 | Assumed instantaneous water level |
| Texas Water Development Board Volumetric and Sedimentation Survey of Lake Texana | 2010 | XYZ | ~500 feet spaced profiles | NAD83 - State Plane Texas South Central Zone (feet) | NGVD29 |
| USACE hydrographic channel condition surveys | 2011 - 2020 | XYZ | ~1 to 10 meters | NAD83 | Mean lower low water (MLLW) |

With the exception of the NOAA NCEI multibeam bathymetric surveys and Texas Water Development Board hydrographic survey of Lake Texana, bathymetric data were transformed from mean lower low water (MLLW) to NAVD88. Vertical datum transformations were performed using NOAA's VDatum Software. Where more recent, higher resolution data existed, older data were edited or superseded.

Bathymetric-topographic data used in developing the South Texas Coast DEMs included bathymetric-topographic lidar from NOAA National Geodetic Survey (NGS), USACE National Coastal Mapping Program (NCMP), and the University of Texas Bureau of Economic Geology (BEG; Table 3).

**Table 3:** Bathymetric-Topographic data sources used in DEM development.

| *Source* | *Date* | *Data Type* | *Spatial Resolution* | *Horizontal Datum* | *Vertical Datum* |
|---|---|---|---|---|---|
| University of Texas Bureau of Economic Geology (BEG): Lower Texas Coast | 2015 | Topographic-bathymetric lidar | ~1 to 3 meter | NAD83 | NAVD88 |
| University of Texas Bureau of Economic Geology (BEG): Shamrock Cove (TX) | 2015 | Topographic-bathymetric lidar | ~1 to 3 meter | NAD83 | NAVD88 |
| USACE NCMP Topobathy Lidar: Gulf Coast (AL, FL, MS, TX) | 2016 | Topographic-bathymetric lidar | ~1 to 3 meter | NAD83 | NAVD88 |
| NOAA NGS Topobathy Lidar Post Hurricane Harvey: Galveston to Corpus Christi TX | 2018 - 2019 | Topographic-bathymetric lidar | ~1 to 3 meter | NAD83 | NAVD88 |

Topographic data used in developing the South Texas Coast DEMs included lidar data from the U.S. Geological Survey (USGS) and the Mexico National Institute of Statistics and Geography (INEGI; Table 4).

**Table 4:** Topographic data sources used in DEM development.

| *Source* | *Date* | *Data Type* | *Spatial Resolution* | *Horizontal Datum* | *Vertical Datum* |
|---|---|---|---|---|---|
| Mexico National Institute of Statistics and Geography (INEGI) | 2012 | DEM | 5 meter | UTM Zone 14N | NAVD88 |
| USGS: Lidar Point Cloud TX RedRiver | 2017 | Topographic lidar | ~1 to 3 meter | NAD83 | NAVD88 |
| USGS: South Texas | 2018 | Topographic lidar | ~1 to 3 meter | NAD83 | NAVD88 |

# DEM Development

Development of the South Texas Coast DEM tiles followed procedures documented in NOAA National Centers for Environmental Information Topo-Bathymetric Digital Elevation Models: East Florida (Amante, 2018). Exceptions being that the bathymetric pre-surface was generated at 1 arc-second due to the coarse resolution of offshore bathymetric data, and gridding weights were modified as shown in Table 5. The bathymetric pre-surface derived from data sources in Tables 2 and 3 was converted to XYZ and was utilized in the final DEM creation. Older, coarse, and/or inaccurate bathymetric surveys from NOAA NOS hydrographic

surveys, NOAA NCEI multibeam bathymetric surveys, and NOAA OCS electronic navigational chart (ENC) extracted soundings were used in the bathymetric pre-surface generation but were not used as source datasets in the final DEM creation with MB-System's 'mbgrid.' An additional interpolated dataset derived from the USACE hydrographic channel condition surveys was also included in the bathymetric pre-surface generation and final DEM creation to guide interpolation between sparse channel conditional survey profiles and more realistically represent the dredged channels.

**Table 5:** Data hierarchy used to assign gridding weights in MB-System's 'mbgrid.'

| ***Dataset*** | ***Relative Gridding Weight*** |
|---|---|
| NOAA NGS Topobathy Lidar Post Hurricane Harvey: Galveston to Corpus Christi TX | 10000 |
| USGS: South Texas | 1000 |
| USACE NCMP Topobathy Lidar: Gulf Coast (AL, FL, MS, TX) | 100 |
| Univ of TX BEG Topobathy Lidar: Lower Texas Coast | 10 |
| Univ of TX BEG Topobathy Lidar: Shamrock Cove (TX) | 10 |
| USACE hydrographic channel condition surveys | 10 |
| NOAA NOS hydrographic surveys: bathymetric attributed grids (BAGs) | 10 |
| USGS: Lidar Point Cloud TX RedRiver | 10 |
| Interpolated USACE hydrographic channel condition surveys | 0.1 |
| Mexico National Institute of Statistics and Geography (INEGI) DEM | 0.01 |
| Texas Water Development Board Volumetric and Sedimentation Survey of Lake Texana | 0.01 |
| Bathymetric pre-surface | 0.000001 |

# DEM Analysis

Once the South Texas Coast DEMs were generated, the DEMs were compared to the high-resolution source elevation data and high-resolution imagery. Inconsistencies were evaluated and resolved based on the most reliable data available. The largest outstanding issues with the DEM tiles are the lack of publicly-available lidar datasets near the Mexico - United States border. In such areas, older, coarser-resolution, topographic data were used from the Mexico National Institute of Statistics and Geography (INEGI). Further, there is a lack of publicly available bathymetry data offshore near the Mexico - United States border. When higher-resolution, publicly available data becomes available for these areas, these DEM tiles will be updated with more accurate, detailed elevation and depth information.

# References

C.J. Amante (2018) NOAA National Centers for Environmental Information Topo-Bathymetric Digital Elevation Models: East Florida, NOAA, pp. 6.
https://www.ngdc.noaa.gov/mgg/dat/dems/tiled_tr/east_florida_tiled_navd88_2018.pdf